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#53355

SPACE BASED SYSTEMS FOR SURVEILLANCE AND COMMUNICATIONS

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80/ The Department of National Defence has a long history of support for the use of space systems to meet National Defence requirements. This use is based on Defence Management Committee guidance for military space activities approved by Cabinet in 1974. The key principles of this guidance are the use of space systems, where most effective, and the development of Canadian industry to support National Defence objectives. These principles have been reiterated in the recently approved DND Space Policy and have been supported by the department's White Paper entitled, "Challenge and Commitment". Although this Defence Policy paper touches on various aspects of space systems such as search and rescue, space object identification etc, of particular interest is the strong emphasis on satellite based communications and space based surveillance to meet future CF needs./

In preparation for system deployment, the Chief of Research and Development Branch has already initiated major R&D projects for approximately $50M each for Space Based

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Radar and EHF SATCOM. These R&D projects over a five year period are intended to preposition Canadian industry, develop in-house and industrial expertise and provide the concept demonstration. Both the projects are managed in the CRAD Branch with the project Management Offices being located at the Defence Research Establishment Ottawa. At this point, I will go into the rationale and some details of each of these projects.

Our interest in Space Based Radar arises from our participation with NORAD in the Strategic Defence of North America and our role in future North American Air Defence. This interest was focussed by the results of the Joint US/Canada Air Defence (JUSCADS) Study commissioned by the Minister of National Defence and the US Secretary of Defense in 1979. This study group was formed to provide a basis for joint planning of continental defence under the NORAD agreement and identified a substantial R&D requirement for a Space Based Radar system to meet future Wide Area Surveillance requirements. In the short term, a modernization program for the Air Defence Radars was to be undertaken and this agreement was concluded in 1985 at the Quebec City Summit. This activity as you are aware is already well underway.

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What are the factors that have led to this new requirement? A review of North American Air Defence shows that during the 1950's when the only threat was the Soviet long-range bomber, deterrence was achieved by deploying extensive air defence systems throughout Canada and the United States. These systems provided an active defence against the bomber threat and were configured for maximum destruction of invading aircraft. Since we did not have adequate resources, for our own defence and vital US interests were at risk, we jointly entered into the North American Air Defence Agreement.

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Soon after the establishment of NORAD in 1957, the predominant threat to North America began to change from that of the Bomber to Strategic Missiles - first the ICBM and then the SLBM. This change to Ballistic Weaponry necessitated a change in thinking. An ABM system - 'SAFEGUARD' was deployed but later stood down due to technical problems. The changing threat and inadequate defences thus led the US to the adoption of a doctrine of Mutual Assured Destruction. This required an extensive surveillance capability and led to the BMEWS, SEWS, PAVE PAWS systems funded by the US, and the gradual reduction of the air defence systems to a level deemed adequate to prevent unopposed use of the Bomber force by the Soviets. Thus, the doctrine of air defence was

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abandoned because even if it were fully effective, it could not offer the US protection from the Nuclear Warheads of the Ballistic Missiles. The Bomber portion of the Soviet TRIAD of Strategic Systems had also declined and the primary mission of the air defence system became one of warning of attack against Canada and the US, allowing sufficient time to mount retaliatory measures. The secondary mission was damage limitation and the third airspace sovereignty as they are to this day.

However, over the years the existing DEW Line and Canadian Pine Tree radars became obsolete and difficult and
VG 4 expensive to maintain. Additionally, the Soviets developed long range, low flying, difficult to detect Air-Launched Cruise Missiles, which could by-pass or underfly the DEW Line, and had the capability to launch their weapons from outside the coverage of the Southern Cadin/Pine Tree radar line. This dangerous and destablizing possibility clearly indicated that the old surveillance systems were inadequate to address the cruise missile threat and led to a 7 Billion dollar program to modernize the air defence system. By
VG 5 measures such as the North Warning System, the deployment of fighters and long-range radars to the coasts and across the north, Over-The-Horizon Backscatter Radars and Airborne Warning and Control System aircraft for indepth coverage, the

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possibilities of the Soviets using the cruise-missile bomber as a leading-edge weapon are significantly diminished. Our CF-18's and the USAF F-15 and F-16 can positively indentify any attacker and provide a degree of damage limitation, but our planners indicate that this is the minimum response required to meet the air-breathing weapons threat. In

VG 6 addition in March 1983, the US embarked on the Strategic Defence Initiative, a research project that, if successful could shift the doctrine from mutual assured destruction to a doctrine of active defence, with deterrence as its fundamental premise. But since this was aimed at Ballistic Missile Defence, which is not a priority with the Canadian government, Canada opted not to participate. In 1985, the US

VG 7 embarked on the air Defence Initiative for research into strategic air defence, with the principal objective being technology development for defence against cruise missiles. This research is of significant importance to Canada and will

VG 8 provide the information required for decisions on future air defence systems.

A significant element of the surveillance technology being investigated under the Air Defence Initiatives is the Space Based Radar. Logically, this will be implemented as the next surveillance mechanism regardless of the doctrine being followed and this imperative is recognized in the

Defence White Paper through a statement that, "Should the results of our studies and those of the United States show that space based radar is feasible, practical and affordable, the Department will have to devote, over the next 15 years, significant resources to the establishment of a space based surveillance system for North American air defence". It goes on to say, "Decisions regarding our contribution to a joint space based radar system, or the development of a National system, if a cooperative endeavour is not possible, will have to be taken in the course of the next 5 - 10 years".

VG 9 The objectives of the current R&D project in Space Based Radar as shown on this chart, closely follow DND policy principles. The first objective identifies the need for us within DND to develop the capability and expertise required to fulfil our role of providing the department with sound technical advice. This will ensure that the planners and decision makers have the expert inputs required to address a program of this magnitude and complexity. The second objective is to develop a Space Based Radar Technology Base within Canada. This includes the development of technologies critical to the success of Space Based Radar matched to our industrial capability, so that a significant technical contribution can be realized from Canada for the joint system. Finally, as a NORAD partner we are exploring

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possible cooperative programs with the US to implement the system. The project received departmental and Government

VG 10 approval on 11 December 1986 and the project office was authorized to begin spending in April 1987. The project work activity is shown in the next viewgraph.

VG 11 The first activity refers to two studies already conducted in Canadian industry. The contractors were required to put forward concepts for a SBR system and to

VG 12 identify key technology areas requiring R&D. In addition, critical technologies most suitable for development in Canada were to be highlighted. The concepts put forth parallel the two philosophies seen in similar US studies. One is the corporate-fed array using Displaced Phase Centre Array (DCPA) and the other the Space-fed array. The Canadian Astronautics Ltd. team proposed a 15 X 30 meters corporate fed phased

VG 13 array at L-band using DCPA with primary power being derived from solar panels. Two configurations, one for use in sun-parallel and the other in sun-perpendicular sun synchronous orbits as proposed, are shown in the viewgraph. The primary

VG 14 tracking area is the fence shown with tracking within the area below the fence also being accommodated.

VG 15 The SPAR team chose the larger aperture space-fed configuration with an antenna 30 X 50mm at L-Band. The

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satellite is operated in a Broom-Sweep mode designed to pass
VG 16 over the polar region. Frequent coverage is provided so that any target can be detected during transit.

(VG 11) Returning to the SBR work activity chart, the second activity is the Advanced Technology Definition and Selection.
VG 17 We have selected a number of technologies from the Concept Studies and for support and contracts in a number of these areas have been initiated. At the same time, the US has also initiated 5 concept definition studies, of similar scope to our already completed studies. We have made substantial progress in defining a cooperative SBR program with the US and it is our intention that this will decide which technologies we select for funding in Activity 3. The latter will form the major portion of the project and absorb most of the funds and hopefully will form the Canadian contribution to a SBR system.

We also see a continuing need for system studies to evaluate system concepts and trade-offs to keep system
(VG 11) performance requirements current with threat models and to evaluate the impact of technology decisions on performance. Finally, provision is made for demonstrations and experiments to show attainment of development objectives and reduction of risk to acceptable levels.

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Clearly, SBR is viewed by the department as being of key importance for the future surveillance of our North American Aerospace. The industry capability exists and we hope that our successful negotiation with the US and their decisions to embark on project implementation will see a system in space soon.

To complete the picture on our space surveillance activities, I would also like to mention our participation in the US TEAL RUBY Experiment. Canada participates in this
VG 18 activity which is designed to evaluate the use of infra-red focal point arrays for air defence applications.

The IR space based sensor developed by Rockwell International for the US Air Force and the Defence Advanced Research Projects Agency (DARPA) is cooled to extremely low temperatures by neon and methane crystals around the focal plane and sensor electronic components. The 11 ft. long sensor telescope barrel includes folded optics to minimize the size/weight of the instruments and uses on-board processing to remove background IR clutter from topographical features the spacecraft is flying over. Though initially scheduled for a 1986/87 launch, the space shuttle disaster has resulted in a hold on the project and it is anticipated that a 1989 launch date is possible.

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With this system which complements the Space Based Radar, we anticipate that most of our Air Defence requirements will be met.

Turning to Satellite Communications, as you are aware, the department initiative in launching the ionospheric-research satellite, Alouette I on 28 Sep 1962 put Canada on the map as the third country in the World in Space. The immediate success of Alouette I led to an expansion of the program into an international program called ISIS, International Satellite for Ionospheric Sounding in which Canada provided three more satellites: Alouette II, ISIS I and ISIS II. I believe some of these satellites are still working.

In 1969 the rapidly growing civilian needs for a space R&D capability led to the transfer of DND's space R&D to the Communications Research Centre. However, DND continued its active participation in international activities and initiated a military R&D space program. Over the years we have been involved in SEASAT and experiments in military communications using FLEETSATCOM, LES satellites and the SKYNET IV.

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The evolution of communication, command and control systems in response to greater weapons system sophistication, the need for rapid deployment and aspects such as interoperability, operations in the Arctic, Northern Forward Operating Locations etc. have all made it essential that we provide secure, survivable communications. Leased landlines, satellite services, LF/HF radio communications all have their shortcomings and with the growing requirements for high data rates, system flexibility, enhanced network survivability, rapid reconfiguration, lower costs, global coverage for tactical and strategic beyond line of sight communications, we have turned to satellites as the only vehicle to meet these requirements. In addition, frequency congestion, technological factors and the need to be as compatible as possible with MILSTAR and the DSCS III follow-on satellites
VG 19 has led us to concentrate on a wideband system operating in the EHF band.

The department established an R&D project in
VG 20 mid-1985 with the goal of demonstrating the applicability of the EHF SATCOM Concept to meet DND's communication needs.
VG 21 This project approved at a level of $48M has the objectives of expanding the military technology base, develop Canadian industrial capability and to collaborate with the US DoD in High Data rate systems.

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Over the past couple of years some opportunities have arisen such as the possibility of putting an EHF package on ANIK E/F satellites, participation in the US MILSTAR and their Post DSCS III - Replacement project and more recently the US NAVSTAR GPS 12 Satellite. Unfortunately for one reason or the other these opportunities have not come to fruition although we are still discussing the possibility of a package on NAVSTAR 12. As such, we have opted to proceed with an independent R&D project to primarily address CF requirements.

As in the case of the SBR project, concept definition studies were initiated with SPAR, CAL, RAYTHEON and COM DEV. These are expected to be completed in November. In parallel, a number of other contracts have been initiated in the technology areas. These include spacecraft synthesizer studies, 44 GHz mixer development, antenna software development, Tracking filter development etc. In addition, contracts have also been placed with SPAR and MICROTEL for the preliminary design of the ground terminal. The project office is developing an implementation plan and addressing the ground segment work plan, whereas CRC support is used for addressing workplans for the system, the space segment and for testing and evaluation.

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VG 22 As in the case of the SBR project we anticipate developing a viable system concept using the results of the contracted studies. With this, Advanced Technology Development will be initiated with industry leading to system testing and demonstration.

VG 23 The system will satisfy the needs of the low data rate users with requirements in the 2.4 KBPS to 64 KPBS range and also medium data rate users with demands at 256 KPBS, 512 or 1.544 MPBS. It will use different communication concepts for both the uplink and downlink. The uplink will use spread spectrum frequency hopping techniques to counter jamming with

VG 24 synchronization between the satellite and ground station being managed by the latter. Individual stations will be separated by Frequency Division Multiple Access (FDMA) in the 44 GHz range. The uplink signal will be frequency de-hopped on the satellite, demodulated, regenerated and then structured into the TDM downlink signal.

VG 25 The downlink signal will be a conventional signal using Time Division Multiplexing (TDM) in the 20 GHz range. The use of full signal regeneration as described before, will result in a separation of the uplink and downlink, thus avoiding 'power robbing' on the downlink by an uplink jammer.

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Jamming effects are further reduced through the use of antenna nulling on the satellite.

(VG 22) A mix of ground terminals will be required to meet our requirements. These include fixed, transportable, submarine, shipborne, airborne, manpack etc. It is anticipated that the low data rate users would use the fixed ground station or large transportable terminal. As shown in the viewgraph, we anticipate embarking on the major contracts in both the space segment and ground terminals in the 1988/89 fiscal year.

In closing, therefore, I wish to emphasize the strong commmitment of the department towards the use of space systems to meet CF needs in keeping with Government and department policies. I believe that the R&D projects I have described to you will meet their objectives of developing Canadian expertise both in-house and industrially and will provide the mechanism for us to deploy these systems cooperatively with our allies or unilaterally if we must.

Thank you for your attention.

SPACE BASED SYSTEMS FOR SURVEILLANCE AND COMMUNICATIONS

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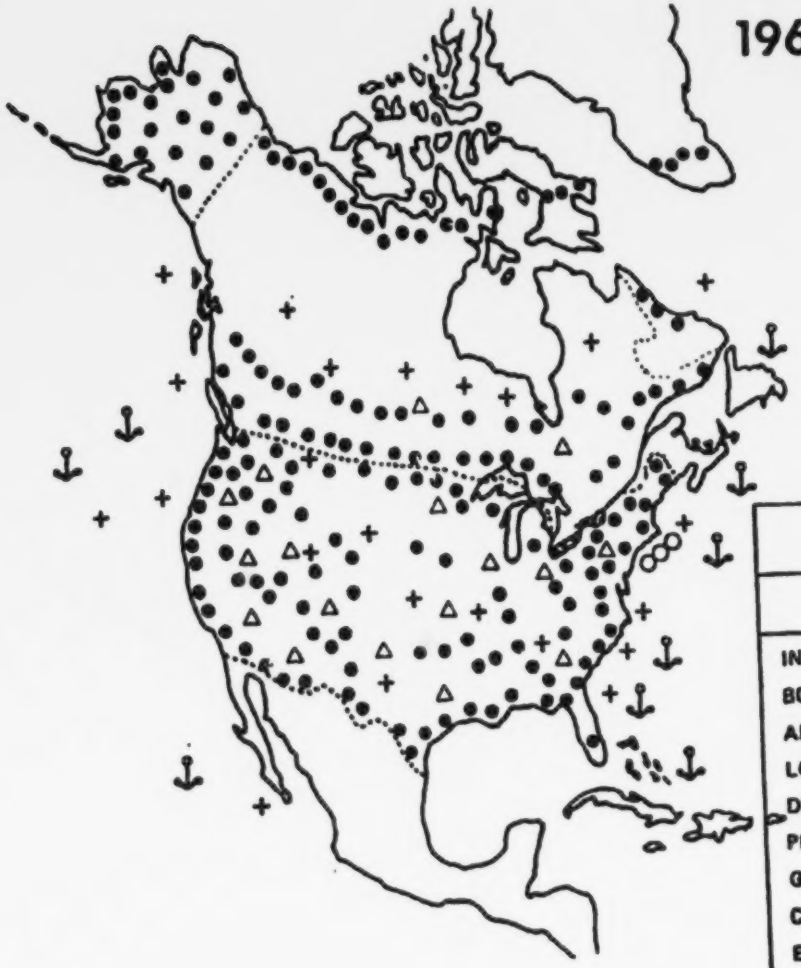
DIRECTOR R&D COMMUNICATIONS AND SPACE

DEPARTMENT OF NATIONAL DEFENCE

OTTAWA



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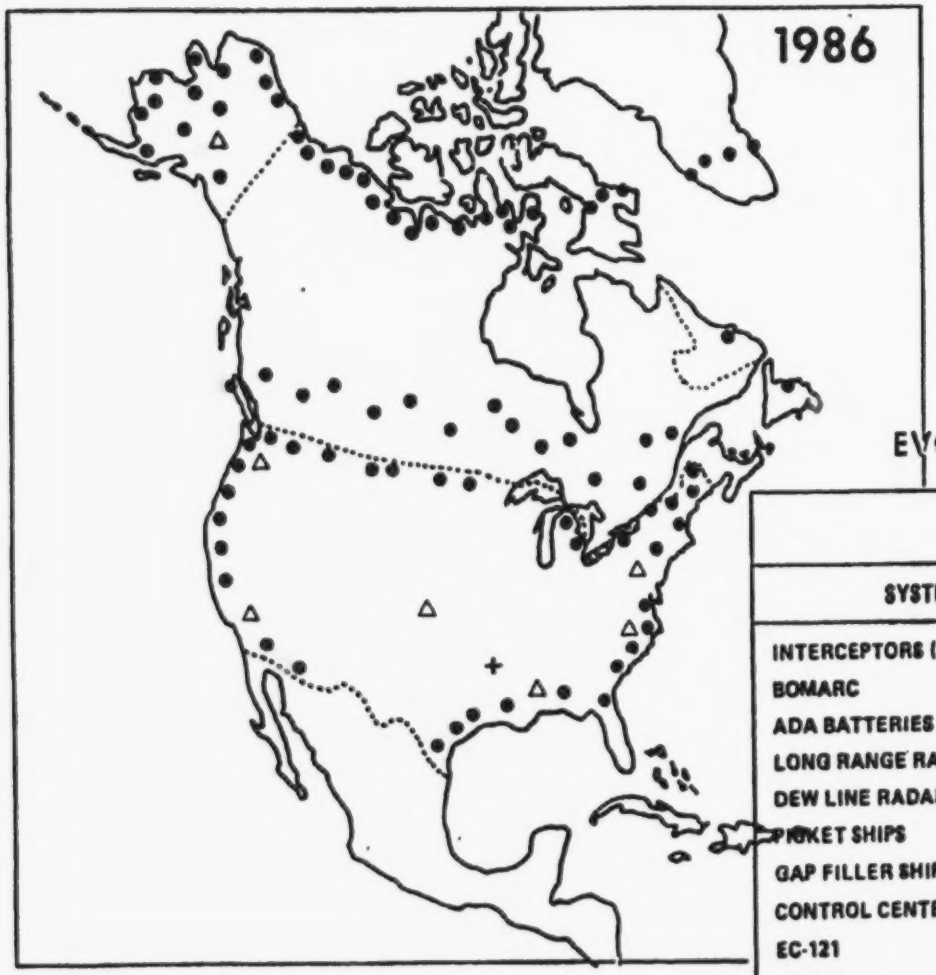
EVOLVING FORCE STRUCTURE

AIR DEFENSE		
SYSTEM	EARLY 1960s	TODAY
INTERCEPTORS (AUGMENTED)	5,714	340
BOMARC	439	0
ADA BATTERIES	274	0
LONG RANGE RADARS	280	65
DEW LINE RADARS	81	31
PICKET SHIPS	11	0
GAP FILLER SHIPS	137	0
CONTROL CENTERS	68	7
EC-121	77	0
AWACS	0	8
MANPOWER	207,000	37,000



EVOLVING FORCE STRUCTURE

AIR DEFENSE		
SYSTEM	EARLY 1960s	TODAY
INTERCEPTORS (AUGMENTED)	5,714	340
BOMARC	439	0
ADA BATTERIES	274	0
LONG RANGE RADARS	286	85
DEW LINE RADARS	81	31
PICKET SHIPS	11	0
GAP FILLER SHIPS	137	0
CONTROL CENTERS	66	7
EC-121	77	0
AWACS	0	8
MANPOWER	207,000	37,000

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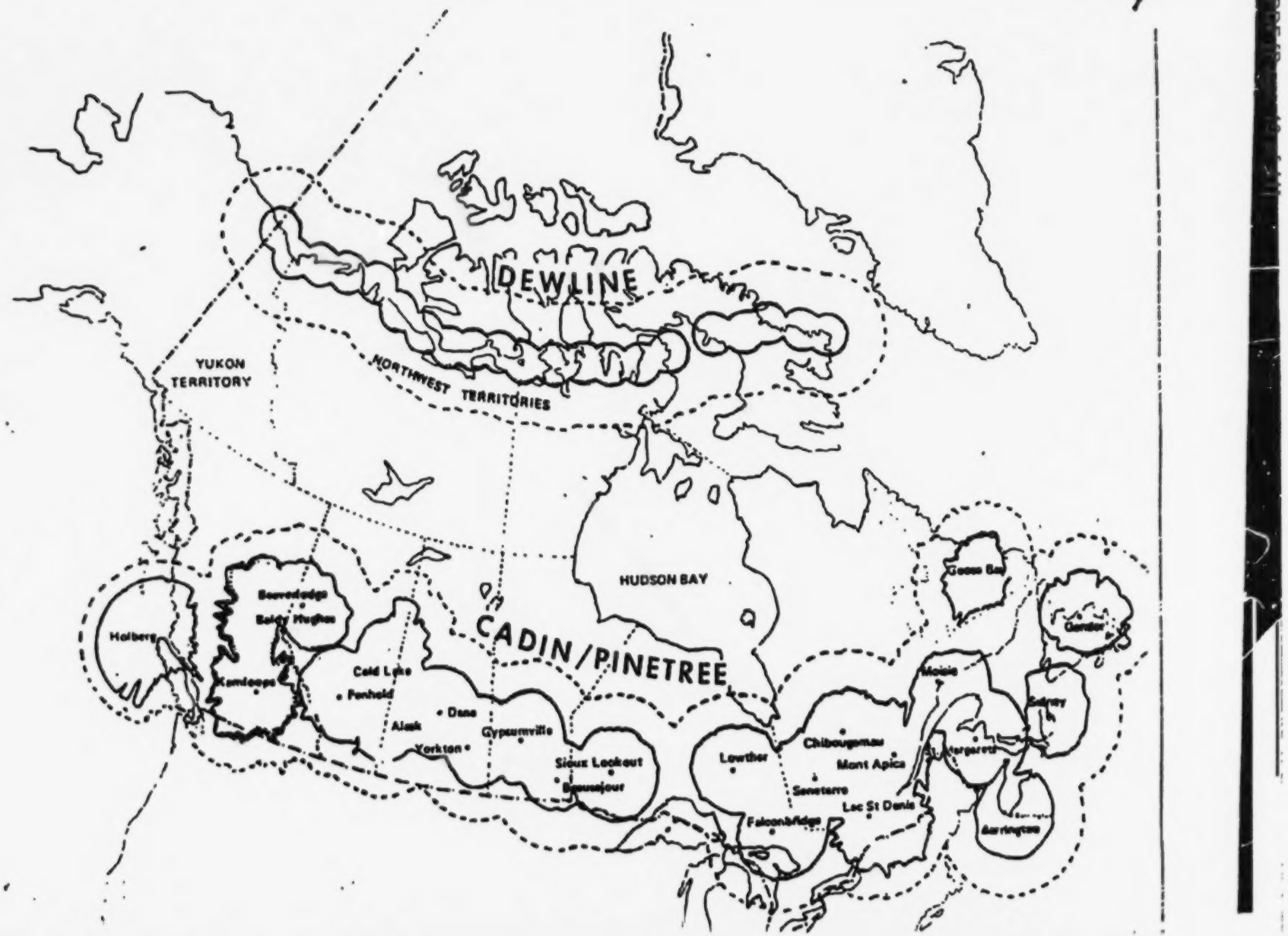
DEWLINE
YUKON TERRITORY
NORTHWEST TERRITORIES
HUDSON BAY
CADIN/PINETREE
Holberg
Beaverlodge
Baker Hughes
Kamloops
Cold Lake
Penhold
Alsek
Dana
Yorkton
Gypsumville
Sioux Lookout
Beausejour
Lowther
Chibougamau
Mont Apica
Senneterre
Lac St Denis
Falconbridge
St Margarets
Goose Bay
Gander
Moisie
Sydney
Barrington

Inuvik
Yellowknife
Rankin Inlet
Kuujjuaq
Legend:
North Warning System
Long-range Radar
Short-range Radar
Coastal Radar
Alaskan Radar
Over-The-Horizon Backscatter Radar
Forward Operating Location

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STRATEGIC DEFENCE INITIATIVE (SDI)

- RESEARCH PROGRAM INTO BALLISTIC MISSILE DEFENCE
- NO GOVERNMENT-TO-GOVERNMENT PARTICIPATION
- RESEARCH PRUDENT AND CONSISTENT WITH ABM TREATY
- GOVERNMENT DEPARTMENTS WILL NOT TAKE PART IN RESEARCH AIMED AT BALLISTIC MISSILE DEFENCE

877370 1414

AIR DEFENCE INITIATIVE

— RESEARCH PROGRAM FOR STRATEGIC AIR DEFENCE

— PROVIDE CRUISE MISSILE SURVEILLANCE (PRIMARY EMPHASIS)

— ENGAGE (INTERCEPT/NULLIFY) TARGETS AT EXTENDED RANGE AND ALTITUDE

— PROVIDE BASIS FOR EARLY-MID 1990'S DEPLOYMENT DECISION

877370 1414

[redacted] [redacted] [redacted] [

SPACE-BASED RADAR PROJECT

OBJECTIVES

1. THE ACQUISITION BY DND OF AN EXPANDED SPACE-BASED RADAR TECHNOLOGY BASE.

2. THE DEVELOPMENT, WITHIN CANADIAN INDUSTRY, OF SPACE-BASED RADAR TECHNOLOGY.

3. COLLABORATION WITH THE US DOD IN EXAMINING POSSIBLE JOINT PROGRAMS FOR IMPLEMENTING A MILITARY SPACE-BASED RADAR SURVEILLANCE SYSTEM.

SBR

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D6471 SPACE-BASED RADAR R&D

ON 11 DECEMBER 1986, TREASURY BOARD APPROVED
THE SBR PROJECT AT A TOTAL COST OF
$47,576,000.

SPENDING ON THE PROJECT WAS AUTHORIZED
TO BEGIN 01 APRIL, 1987.

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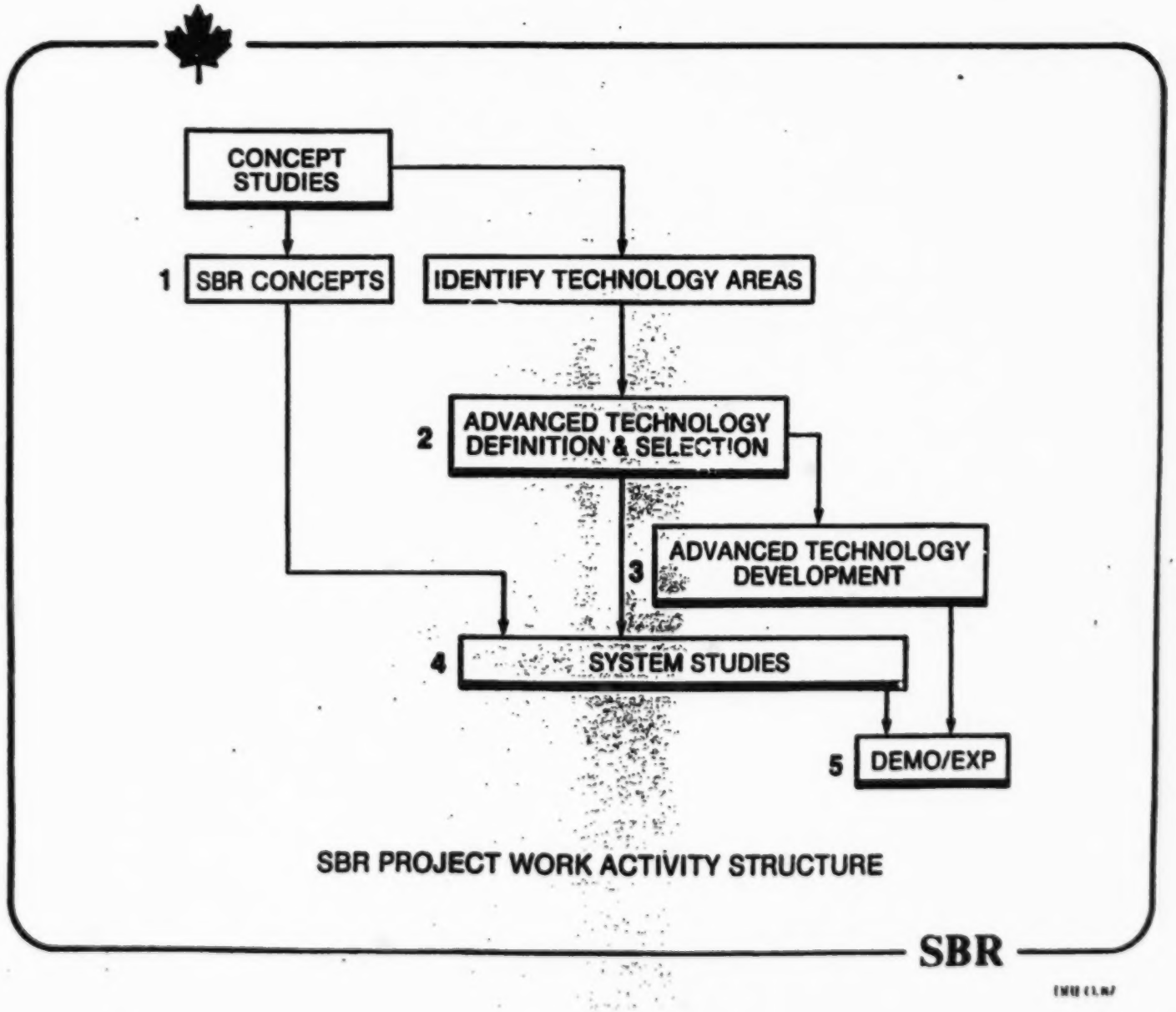
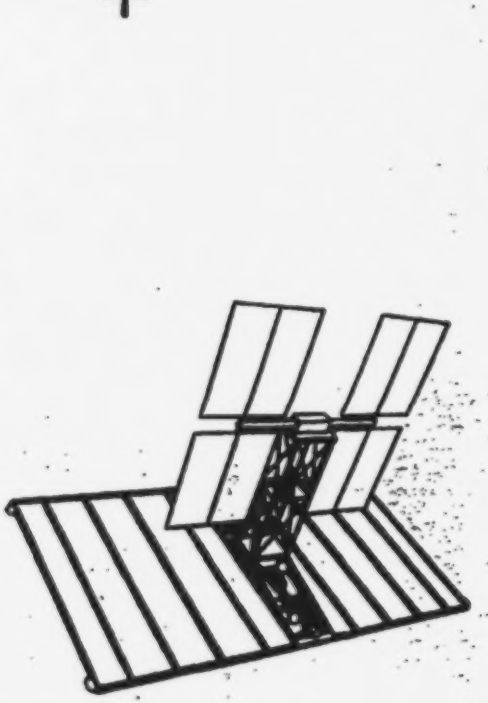


SBR SYSTEM CONCEPT STUDIES

- DERIVED SBR SYSTEM ARCHITECTURE
- ANALYSED CRITICAL TECHNOLOGIES
- IDENTIFIED TECHNOLOGIES OF PARTICULAR INTEREST TO CANADA



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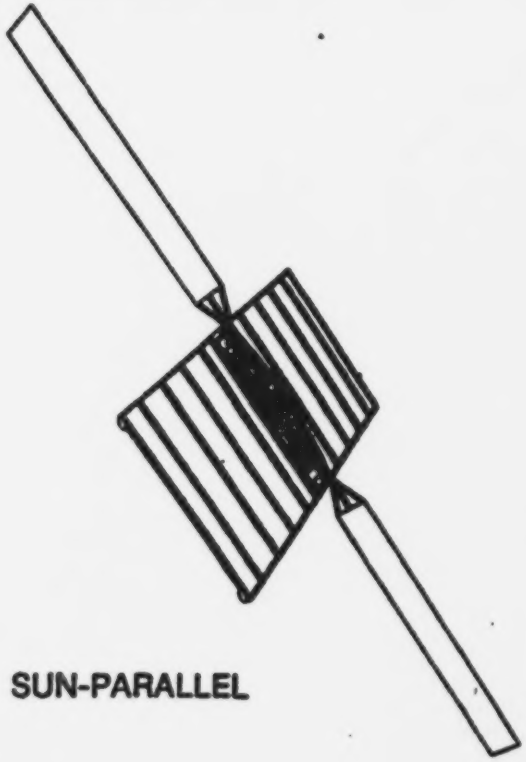
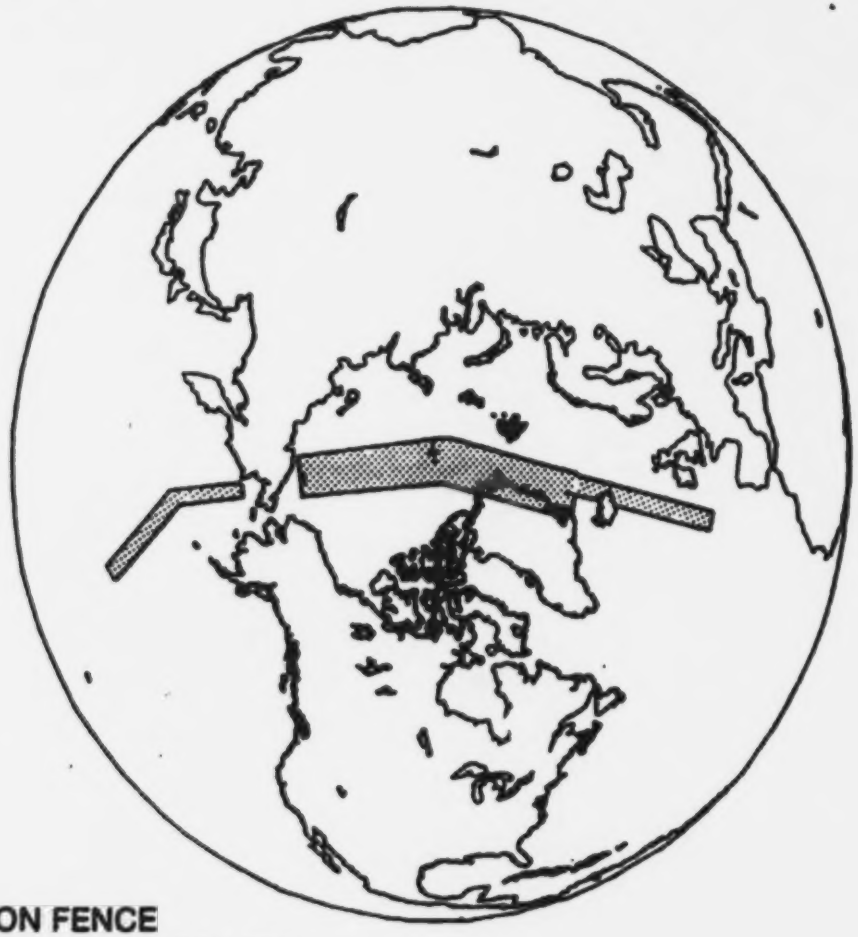


SUN-PARALLEL

CORPORATE FED SUN-SYNCHRONOUS SBR SATELLITES
CANADIAN ASTRONAUTICS LTD.

SBR



SBR DETECTION FENCE
CANADIAN ASTRONAUTICS LTD.

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SPACE-FED SBR SATELLITE
SPAR AEROSPACE LTD.

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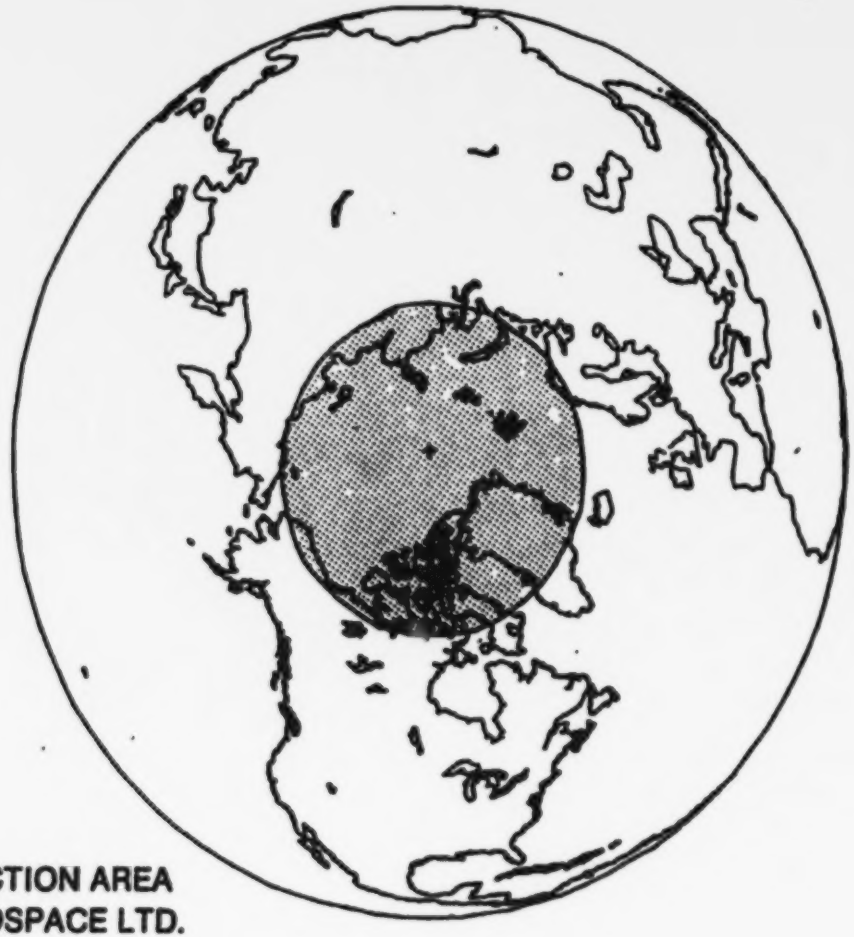

SBR DETECTION AREA
SPAR AEROSPACE LTD.

SBR

DRDC '87

TECHNOLOGY DEFINITION STUDIES

1. Power Distribution and Control
2. Optical Feed Techniques
3. GaAs MMIC T/R Modules
4. Multi-Target Tracking
5. Target Detection
6. Large Structures Mechanical Testing
7. ECCM/Adaptive Nulling
8. Signal Processor Technology
9. Antenna Electrical Testing
10. Antenna Shape Measurement/Control

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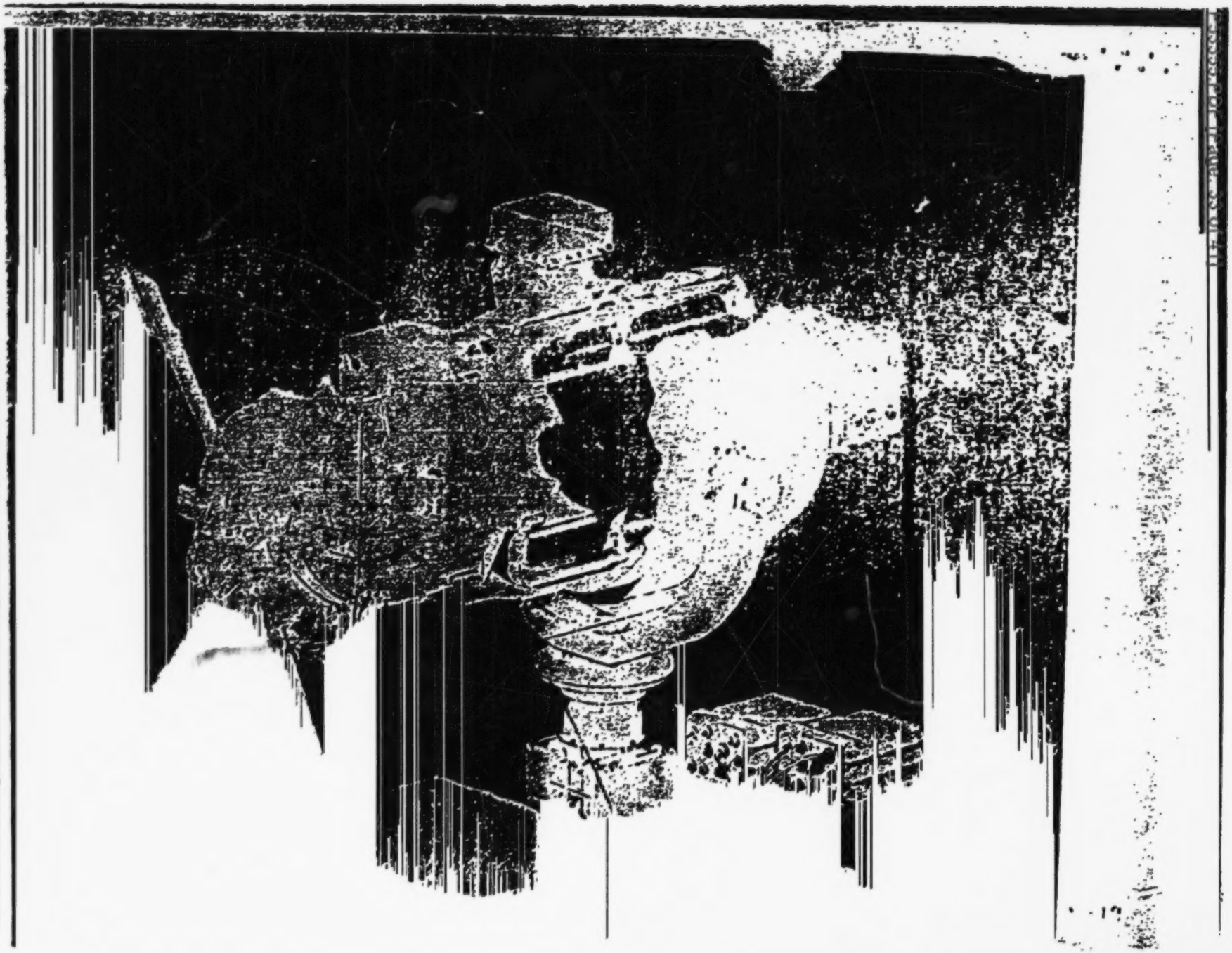
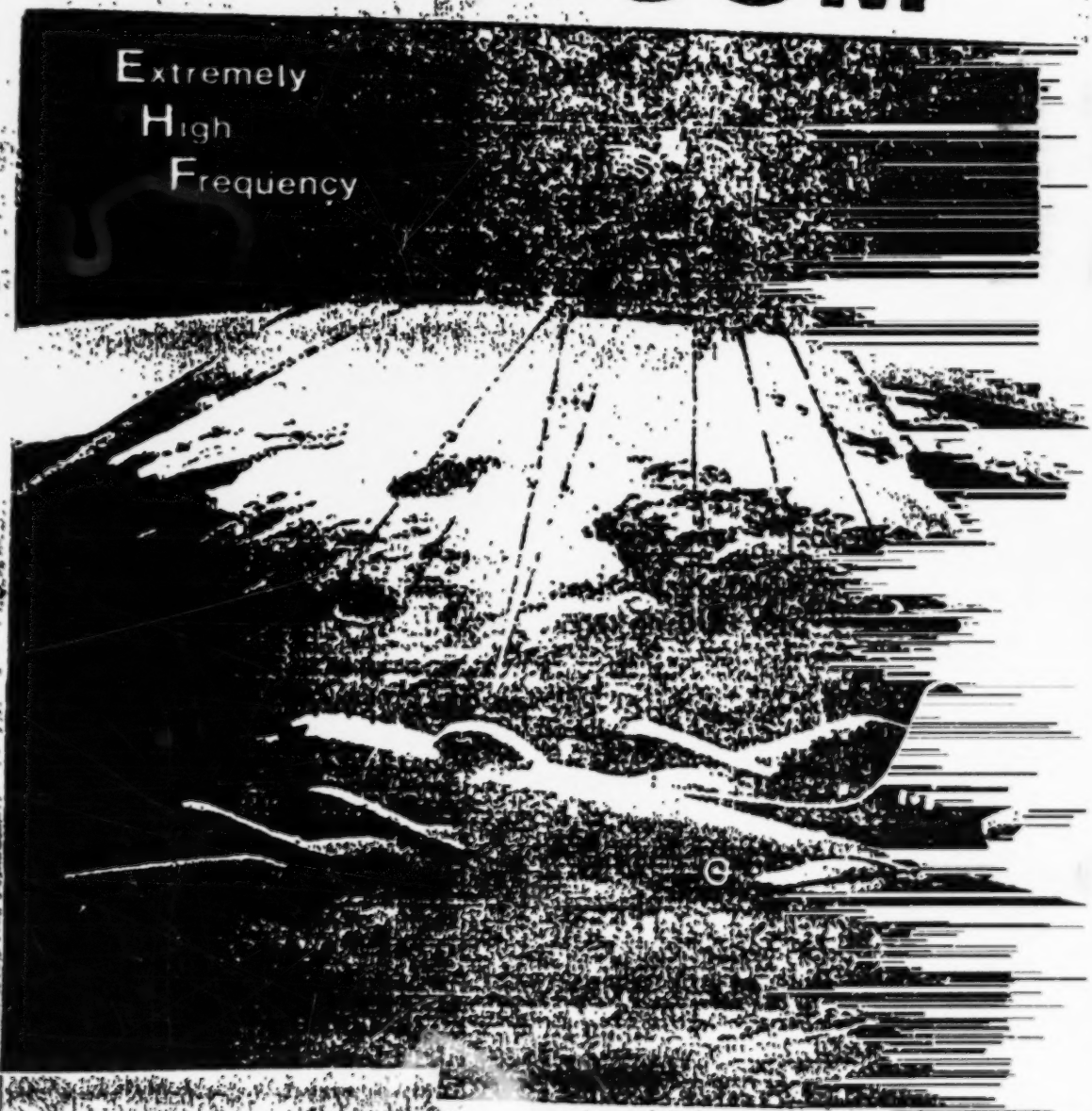


SATCOM



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EHF SATCOM PROJECT

GOAL

TO DEMONSTRATE THE APPLICABILITY OF THE EHF SATCOM CONCEPT TO MEET DND'S COMMUNICATION NEEDS NEEDS OF THE FUTURE.

OBJECTIVES

EXPAND MILITARY TECHNOLOGY BASE

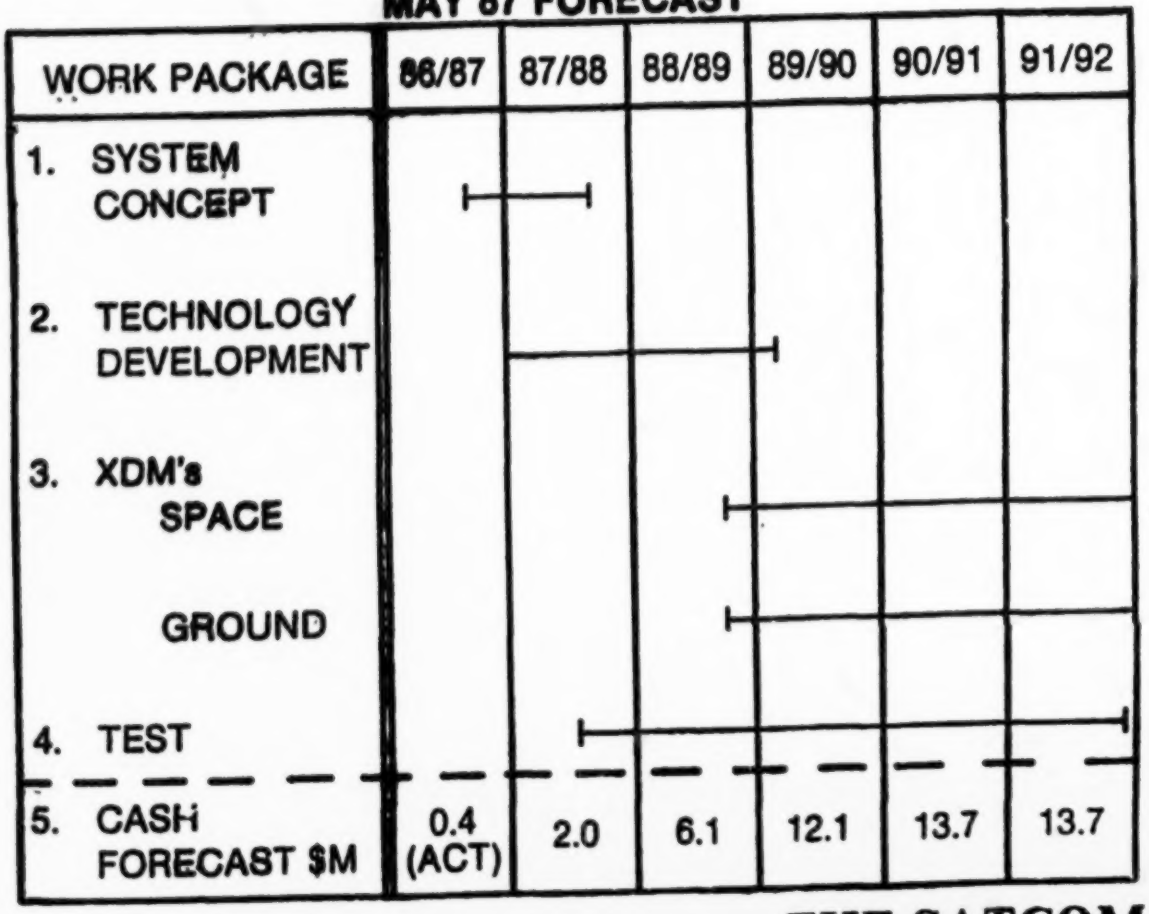
DEVELOP CANADIAN INDUSTRIAL CAPABILITY

COLLABORATE WITH US DOD IN R&D OF HIGH DATA RATE SYSTEM

D6470

EHF SATCOM PROJECT

MAY 87 FORECAST



EHF SATCOM

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DATA RATES

- LOW 2.4 KBPS - 64 KBPS
- MEDIUM 64 KBPS - 1.544 MBPS
- HIGH > 1.544 MBPS

UPLINK

- CENTRE FREQUENCY - 44 GHz
- LOW DATA RATE USERS > 8
- MEDIUM DATA RATE USERS 4
- FREQUENCY HOPPING

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DOWN LINK

- CENTRE FREQUENCY - 20 GHz
- TDM
- POTENTIAL FOR FREQUENCY HOPPING